

SUBJECT: MSF Earth-Sensing Experiment
Program - Task 27 - Case 227

FROM: W. W. Elam

The Meteorology and Earth Science and Resources areas of the Office of Manned Space Flight Experiments Program are discussed. Program planning is reviewed and the special problems of planning in these disciplines are pointed out. The disciplines which are discussed are meteorology, agriculture and forestry, geology and hydrology, geography and cartography, and oceanography. A timeline into the post-1980 period for Earth-sensing flights and supporting activities to serve these disciplines is presented.

The experiments in the MSF/Bellcomm experiments file are compared with those required to support the recommended programs and are found to constitute a generally satisfactory program at this time if fully supported. Technical areas that should be highlighted or strengthened are: determination of the state parameters and motion of the atmosphere on a global basis, and the inclusion of passive microwave imaging experiments to meet stated requirements of user agencies.

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SUBJECT: MSF Earth-Sensing Experiment
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DATE: November 16, 1966

FROM: W. W. Elam

MEMORANDUM FOR FILE

I. INTRODUCTION

Remote sensing of the Earth's resources and environment promises many fruitful applications for spacecraft.

An objective assessment of so broad a range of possibilities is beyond the scope of this paper. This scope is necessarily restricted to indication of broad interest expressed by groups well fitted to profit by the "applications" if they materialize and prove economically feasible. The "applications" areas of meteorology, agriculture and forestry, geology and hydrology, geography and cartography, and oceanography are considered.

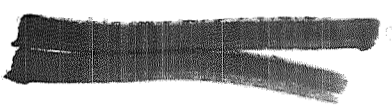
The expressed interest and plans of these groups are expressed in a potential timeline leading to operational spacecraft services. Because other government agencies are served, the planning and administration of this NASA program is more complex than for most other areas of the space effort. It must be in concert with development in the user agencies and provide for the supply of many different types of data to many different users.

The early needs of these programs are compared with the experiments currently used in MSF planning, the MSF experiments catalog. The coverage is good with one exception, the lack of a passive microwave imagery experiment for oceanography or terrain sensing. More than one half of these experiments listed are candidate experiments for the "Applications A" and "Applications B" packages proposed for flight in the Apollo Applications Program.

II. METEOROLOGICAL PROGRAM

Program Definition

NASA shares responsibility for the national operational satellite program in meteorology with the United States Weather Bureau, now under the Environmental Science Services Administration, (ESSA). In a basic agreement between the two agencies made in



1964 (Ref. 1) it was specified that NASA should (1) fund and carry out the research and development of supporting technology and (2) design, build and supply operational spacecraft and launch vehicles. The Weather Bureau, on the other hand, should (1) determine program requirements, (2) fund NASA's operations in supplying the operational system, and (3) fund and administer the use of the system. Both agencies were to be responsive to the needs of other user groups such as the DOD, FAA, etc.

In its program requirements the Weather Bureau then requested NASA (Ref. 2) to develop a satellite capability to provide, in order of priority,

1. Global observations on a regular basis including:
 - a. visible and IR imagery of cloud systems from near-Earth polar orbiting satellites, and
 - b. global heat budget measurements with accurately calibrated instrumentation.
2. Meteorological observations from synchronous satellites providing continual surveillance of areas of prime interest.
3. Global observation of atmospheric structure needed for numerical weather forecasting:
 - a. indirect sensing of the state parameters (temperature, density, pressure) and motion, and
 - b. satellite interrogation of atmospheric sensing platforms (buoys, automatic land stations, constant altitude balloons, etc.).

The need for such a program on a global basis both for long range forecasting and for weather modification has also been stressed in panel reports of the National Academy of Sciences - National Research Council (Refs. 12, 13).

These requirements may be further extended as a result of a current study of ESSA (Ref. 11) to include observations of surface conditions, special phenomena (forest fires, floods, hurricanes, etc.) and support for weather modification experiments.

The unmanned satellite program starting with Tiros, and now Nimbus for research and development and the operational ESSA series, is well started on the way toward accomplishing these goals. Goal 3, measuring structure within the atmosphere, which is the most important for major improvement in weather forecasting, is the furthest from realization. The Meteorological Program Office of SAA is planning a manned spacecraft meteorological experiments program in the NASA role of developing new technology. Three contracts to study such a program have been let to private research organizations.

(Geophysics Corp. of America, Electro-Optical Systems, and Aracon Geophysics), and the final reports from the contracts are now available (Ref's 4, 5, 6).

Looking more to the future, ESSA is conducting a study on longer range goals of the possible applications of space technology (Ref. 3). A portion of this study deals with the role manned spacecraft can play in helping ESSA provide environmental services on a national and international basis. This study is now being completed and will be made available shortly. The status and documentation of recommendations for a meteorology program are summarized in Table I.

The following conclusions summarize those reached in the ESSA study and in the three contractor studies:

1. Because of the requirement for continuous, routine coverage, any operational meteorological satellite program is likely to be principally unmanned; this will certainly be true at least until very long-life manned space stations are established.
2. Early manned flights will offer great assistance in determining what the operational system should be. Prototype instruments can be evaluated directly without having to develop sophisticated automatic systems for calibration and control. The weight capabilities of manned vehicles will permit adequate data collection to test mathematical models of the atmosphere. Thus, the meteorological program will need a certain number of heavily instrumented manned vehicles at its disposal.
3. Manned observatories are especially valuable in weather research because they provide flexibility in choosing the techniques and the resolution appropriate to particular weather patterns when discovered.
4. Finally, it is very likely that the development of new sensors and techniques (radar, IR and microwave particularly) used in the Earth Resources Survey Program for other purposes will provide valuable data for meteorology at the same time. For example, sea and Earth surface temperatures and roughness parameters are of interest to weather prediction as well as to sea and Earth studies. These multiple uses will require careful plans for data relay and exchange.

The Meteorological Experiment Program

We now examine the experiments in the MSF/Bellcomm file relevant to meteorology. These are listed in Table III and rated 1, 2 or 3 in relative importance to reasonable program goals. We find sixteen experiments listed of primary importance and fourteen others which are of secondary importance.

Major steps in meeting the important requirement of global observation of atmospheric structure are being taken in the Applications A group of experiments, scheduled for 1969. In this are six experiments which attack the problem directly and four other experiments which will provide background or supporting data.

Hence, it must be concluded that compared with reasonable goals for an MSF meteorology program, the experiments now well defined in the file are a substantial part of those needed. Remote sensing of atmospheric state parameters and the attendant data handling and communications problems should be vigorously pursued.

III. THE NATURAL RESOURCES PROGRAM

The "other" part of the Earth sensing program is undergoing definition in OSSA in a manner considerably different from that for meteorology. Under the broad heading of "Natural Resources and Geoscience" manned satellite remote sensing programs were studied and defined under SAA/Manned Space Sciences. The effort is continuing under the OSSA Natural Resources Survey Program in the Division of Space Applications. A number of remote sensing investigator teams have been formed. These teams may be arbitrarily divided into two types "instrument" and "applications" teams

The proposals for flight experiments will come primarily through the instrument teams but are directly responsive to the requirements developed by the "applications" teams. Such instrument teams of particular interest to Earth sensing are:

1. Photography-Optics (Multispectral, Panoramic, Cartographic)
2. IR Imagery, Spectroscopy and Photometry
3. Passive Microwave Radiometry and Imagery
4. Radar Imagery and Altimetry and RF Reflectivity
5. Radio Frequency Reflectivity

6. Absorption Spectroscopy (Remote Trace Element Detection)
7. Gravity Gradient Sensing
8. Magnetometer Sensing

The "applications" teams arise from the NASA agreements with other government agencies. They are charged with assisting NASA in determining the national requirements. They are:

1. Agriculture and Forestry Applications - U.S.D.A.
2. Geologic and Hydrologic Applications - U.S.G.S.
3. Oceanographic Applications - U. S. Navy (Naval Oceanographic Office)
4. Geographic Applications - U.S.G.S.

Overall coordination between teams is affected through the NASA/SAR Remote Sensor Coordinating Committee under the co-chairmanship of P. C. Badgeley/SAR and R. G. Reeves/SAR.

Other activities supporting the Earth-sensing programs are being coordinated by the following Natural Resources Program groups:

Remote Sensing Test Site Group

Aircraft Coordination Group

Data Handling Group

Ground Truth and Statistical Sampling Group

A major effort in Earth-sensing is being made in investigating and evaluating the sensing techniques by means of aircraft-carried sensors operating over control or "ground truth" test sites. The result of these efforts will aid in defining the spacecraft instrumentation and in interpreting the data sensed from spacecraft.

Program Definition by Inter-Agency Agreements and the Applications Teams

1. Agriculture and Forestry - The program in Agriculture/Forestry is best defined in a statement of agreement (Ref. 7) between the Department of Agriculture and NASA. The overall objectives for an experiment program listed are:

- a. To obtain remote observations of spatial and spectral signatures for plants, animals, and soils.
- b. To use data so obtained to recognize or establish relationships among productivity, distributions, and concomitant natural and man-made phenomena.
- c. To determine how the comprehensive view available in space may best be utilized to perform resources surveys for Agriculture/Forestry.

It is recommended that the manned earth orbital experiment program include the major areas of vegetation, soils and animal life, and that the program should bridge the gap between current aircraft based research and the ultimate operational space systems.

2. Geology and Hydrology - The USGS is the lead government agency in the geology-hydrology applications team. A study by the USGS has resulted in a report (Ref. 8) giving a detailed plan for the USGS-NASA Geology-Hydrology program for FY 1966. The rationale and objectives for this program are listed in the associated work statement as 1) improving man's knowledge of the solid earth and the distribution of its resources (including water) relatively rapidly, and 2) improving man's ability to discover hidden resources.
3. Geography and Cartography - The geographic applications team has been recently organized. Geographic interests are included in the work and proposals of the instrument teams.

Overall program planning efforts are now under way in this area. Limited specific goals are defined in the USGS report cited above (Ref. 8).

4. Oceanography - Some study contracts have been let. A shortage of competent investigators ready to take on the work has been a problem. Oceanographic interests have been included in the work of the instrument teams.

The authority for planning and carrying out a joint program for oceanography between the United States Naval Oceanographic Office and NASA was set up in an exchange of letters between Dr. R. C. Seamans, Jr. and Dr. R. W. Morse, Assistant Secretary of the Navy, in September and October of 1965. A detailed plan has now been issued (Ref. 9) for the U.S.N. Oceanographic Office participation in the NASA Natural Resources Program.

The program objectives are summarized from this plan as follows:

- a. To increase man's knowledge and understanding of the mechanisms underlying oceanography using the unique advantages of spacecraft;
- b. To assess instruments and techniques and investigate methods of handling and coordinating data; and
- c. To assess man's potential in a spaceborne system for augmenting the amount and quality of oceanographic data gathered.

Potential areas of application are listed as: shipping, fisheries, air-sea interaction, oceanographic survey, sewage disposal and marine recreation. Specific technical areas of interest are given as waves and currents, thermal mapping, coastal and marine geology, sea ice, oceanographic forecasting, marine biology and verification of doubtful hydrographic data.

Summary of Resources Program Definition Status

The program definition status is shown in Table II, and can be summarized as follows:

1. Agriculture and Forestry - Program defined in broad objectives by joint statement of agreement between USDA and NASA (Ref. 7), and U.S.D.A. detailed plan (Ref. 9).
2. Geology and Hydrology - Program objectives defined in NASA-USGS work statement; FY 1966 plan defined by USGS report (Ref. 8).
3. Geography and Cartography - Program partially defined by USGS report (Ref. 8).
4. Oceanography - Program plan enunciated by U. S. Naval Oceanographic Office Plan, (Ref.10).

A statement of broad program objectives in the entire remote sensing resources program is given in the recent "OSSA Prospectus - 1966, The Natural Resources Program", (Ref.11).

The Experiment Program Currently Proposed for Remote Sensing of Resources

The applicability and relative importance of the currently proposed MSF experiments to the above four earth science disciplines are shown in Table III. As for meteorology, they are rated 1, 2 or 3 as judged in relative importance to the programs involved. It is seen that all four areas have seven or more applicable MSF experiments proposed judged of primary or secondary importance. Geology and hydrology have twelve such experiments. This fairly good coverage results from the fact that in large measure the experiments have been proposed as a result of work by applications and instrument teams after considering the program needs. It appears that the proposed experiments represent a good beginning program.

The important central core of experiments in this group are the candidate experiments for the Applications B flight scheduled for 1971. They are identified in Table III. The flight of this group of complementary experiments on the Applications B mission is an essential early milestone in the natural resources survey program.

A weakness appears in the absence of any proposed experiments providing passive microwave imagery of the spatial resolution (~5 km from 200 nautical miles altitude) to meet the stated requirements of user agencies.

Timelines of Earth-Sensing Programs

A desirable timetable of the development of the natural resources survey program has been formulated in the OSSA prospectus for 1966 (Ref.11). Actual times will depend upon speed of technical progress, flight program results and the funding levels in NASA and the user agencies. The timelines for the overall Earth-sensing program presented here differ from those in Ref.11 in assuming that a less than optimum level of support can be secured. A maximum level of support could reduce times up to 25% for the early milestones and up to 50% for the later milestones.

The flight program for all areas of Earth-Sensing divides into three phases:

1. The feasibility phase, 1964 to 1971, involves;
 - a) sensing from aircraft over carefully controlled and selected test sites which are providing imagery and other data for scientific use, 2) establishment of data handling facilities and development of analytical procedures, and c) definition of spacecraft instrumentation parameters.

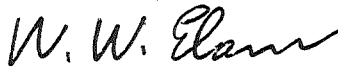
2. Spacecraft testing, 1969 to 1979, will involve sensing mainly over test sites as only a limited amount of data can be obtained. Area sensed and amount of data obtained will increase as techniques are improved. Applications A in 1969 and Applications B in 1971 are important early milestones in this phase. During this phase the basic economics of spacecraft sensing will be determined, and techniques for improved data processing and practical application of processed data will be perfected.
3. Operational, 1975 and on, will involve multi-instrument global sensing on a more or less continuous basis beginning about 1980. Some flights may be used for operational purposes beginning about 1975.

A rough portrayal of these flight program timelines is included in Fig. 1 on graphical timelines for development in the individual disciplines.

IV. CONCLUSIONS AND RECOMMENDED ACTION

In the technical area a comparison of experiments in the MSF/Bellcomm file with program goals as defined, or in some instances estimated, shows that in large measure the experiments, if funded, would constitute an excellent program. One exception is that there is need for a passive microwave imaging experiment to meet stated requirements of user agencies in the natural resources program. A study contract to determine the specifications of an instrument to meet these requirements as described in a work statement prepared by the United States Naval Oceanographic Office should be supported as a high priority task.

In conclusion, it is reemphasized that the earth-sensing program is highly complex. A number of potential users are involved, each drawing on data from several classes of instrument; as a result, the problem of reducing and disseminating data is large. A unified well planned program will be necessary if potential benefits of Earth sensing are to be evaluated and the valid applications implemented in a reasonable time.


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Attachments
References
Figure 1
Tables I - III

Copy to
(See next page)

Copy to

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3. Man's Environment - A Study from Space Environmental Science Services Administration Draft, to be released October, 1966.
4. EOS Report 7002 - Final, March 3, 1966, Contract No. NASW-1297.
5. GCA Technical Report No. 66-10-N, March, 1966, Contract No. NASW-1292.
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10. Detailed Plan for the United States Naval Oceanographic Office Participation in the NASA Natural Resources Program, March, 1966.
11. Prospectus, the Natural Resources Program of the Office of Space Science and Application of the National Aeronautics and Space Administration, March 30, 1966.

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12. The Feasibility of a Global Observation and Analysis Experiment, National Academy of Sciences - National Research Council, publication No. 1290, 1966.
13. Weather and Climate Modification - Problems and Prospects, National Academy of Sciences - National Research Council publication No. 1350, 1966.

Figure I

Estimated Timeline for Development
Earth Sensing Capabilities

		1970	1975	1980	1985
Meteorology	Use full operational imaging (operational unmanned spacecraft)	Develop capability to sense state of atmosphere and boundaries (limited flights on manned spacecraft)	Achievement of capability to sense the atmosphere and its boundary layers - Development means to use effectively the data operationally (longer duration manned spacecraft flights - unmanned flights)	Operational capability to remotely sense the atmosphere and boundary conditions and important phenomena and put data to operational use (continuous sensing by manned and unmanned spacecraft)	
Agriculture/ Forestry	Achieve minimum interpretation capability	Achieve basic understanding of data/subject relationships (short duration space flights sensing test sites)	Optimize sensing techniques and data handling and usage techniques (long duration spacecraft flights covering extended areas)	Operational for user disciplines (large multi-instrument, multi-discipline flights coverage and duration as required by user agencies)	
Geology/Hydrology	"	"	"	"	
Geography/ Cartography	"	"	"		"
Oceanography	"	"	"		"

TABLE I
RECOMMENDATIONS FOR REMOTE-SENSING METEOROLOGICAL PROGRAM

Discipline	Group Making Recommendation	Document	Content
Meteorology	ESSA (Weather Bureau)	See reference 1, 2	Statement of goals for a satellite meteorology program.
	ESSA (J. Kuetner)	In-house study in progress of uses of spacecraft See reference 3	Study of use of spacecraft (manned and unmanned) to support the operational services for which ESSA is responsible in the various Earth sciences.
	NASA/SAM Meteorological Program Office	Technical studies by three contractors. See references 4, 5, and 6	Use of manned spacecraft in meteorology.

TABLE II
RECOMMENDATIONS FOR REMOTE-SENSING EARTH RESOURCES PROGRAM

Discipline	Group Making Recommendation	Document	Content
Agriculture and Forestry	NASA/SAR Agriculture & Forestry Applications Team USDA-lead agency USDA	See ref. 7, 9	<p>Advises NASA on national agricultural and forestry requirements for data.</p> <p>Participates with instrument teams in the preparation of proposals for spacecraft flight experiments.</p> <p>Supports and conducts supporting studies, research and experiments.</p> <p>Goals of USDA for remote sensing program in Agriculture/Forestry</p>
Geology and Hydrology	NASA/SAR Geologic Applications Team (USGS lead agency). USGS	See ref. 8	<p>Team advises NASA on a satellite remote sensing program representing the national interest concerning geologic and hydrologic uses.</p> <p>Supports and conducts supporting studies, research and experiments</p> <ol style="list-style-type: none"> 1. Cartography 2. Environmental geology and mineral resources 3. Hydrology

Discipline	Group Making Recommendation	Document	Content
Geography and Cartography	NASA/SAR Geographic Applications Team (USGS-lead agency)		Team will represent national interest to NASA concerning geographic and cartographic uses of satellite sensed data and recommend a program.
	USGS	See ref. 8	See Geology and Hydrology.
Oceanography	NASA/SAR Oceanographic Applications Team (USN Oceanographic Office-lead agency)		Team advises NASA on national oceanographic requirements for data sensed from spacecraft.
	U.S. Navy Oceanographic Office	See ref. 10	Detail plan and schedule for spacecraft oceanography program.

TABLE III
PRESENTLY PROPOSED EXPERIMENTS IN THE EARTH DISCIPLINES

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PROPOSED EXPERIMENTS IN MSF EXPERIMENTS CATALOG	EARTH SCIENCES DISCIPLINE SERVED					REMARKS
	Agriculture/ Forestry	Geology/ Hydrology	Geography	Meteorology	Oceanography	
EJ0275 (S006) Synoptic Weather Photography (Nagler)				3		Flown on Gemini. Has demonstrated potential of photography from spacecraft
EJ0080 (S007) Cloud Top Spectrometer (F. Saidey)				2		Flown on GT-5
EJ0494 Circulation in the Upper Atmosphere (Ohring)				1a		Objectives related to those of EJ0272 and EJ0570
EJ0570 (S051) Daytime Sodium Cloud Experiment (Blamont)				1a 2b		A simple feasibility experiment Objectives are related to those of EJ0272 and EJ0494.
EJ0272 Upper Atmosphere Wind Measurements (Bedimger)				2a		Difficult technical problems. EJ0494 and EJ0570 have related goals.
EJ0292 Photometric and Polarimetric Observations of the Earth (Greenspan, Owen)				3b		Some elements of purpose similar EJ0474; main purpose planetary atmosphere.
EJ0278 (S040) Dielectric Tape Camera (Arlaukas)	3	3	3	1b	3	Part of the Applications A package

KEY:

1 = Primary Importance
2 = Secondary Importance

3 = Peripheral Importance
a = Of Scientific Interest Primarily
b = To Develop Fundamental Information or Technique

TABLE III - 2

PRESENTLY PROPOSED EXPERIMENTS IN THE EARTH SCIENCE DISCIPLINES (CONT'D)

PROPOSED EXPERIMENTS IN MSF EXPERIMENTS CATALOG	EARTH SCIENCE DISCIPLINE SERVED					REMARKS
	Agriculture/ Forestry	Geology/ Hydrology	Geography	Meteorology	Oceanography	
EJ0513 (S039) Day-Night Camera (Moody)				1b	3b	Part of the Applications A package.
EJ0599 Diurnal Effects on Cloud and Weather Formation (Coulson)				2		Proprietary-Purpose of instruments similar to that in EJ-0513.
EJ0274 (S043) Infrared Temperature Sounding (Shaw)				1		Part of the Applications A package.
EJ0515 (S050) Atmospheric Temperature Profile with Infrared Spectrometer - SIRS (Wark)				1	3	ESSA experiment; part of the Applications A package.
EJ0396 (S047) Atmospheric Structure by Star Occultation (Fischbach)				1		Part of the Applications A package.
EJ0640 Selective Chopper Radiometer (Houghton)				1		Purpose and technique similar to that of EJ0515. Method and instrument is possible improvement. Part of the Applications A package.

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TABLE III - 3
PRESENTLY PROPOSED EXPERIMENTS IN THE EARTH SCIENCE DISCIPLINES (CONT'D)

PROPOSED EXPERIMENTS IN MSF EXPERIMENTS CATALOG	EARTH SCIENCES DISCIPLINE SERVED					REMARKS
	Agriculture/ Forestry	Geology/ Hydrology	Geography	Meteorology	Oceanography	
EJ0474 (S046) Polarization of Radiation from the Top of the Atmosphere (Sekera)				2 1b		Part of the Applications A package.
EJ0502 (S045) Near IR Filter Wedge Spectrometer (Hovis)	2b	2b	3b	1b	2b	Part of the Applications A package.
EJ0511 (S049) High Resolution Infrared Spectroscopy (Hanel)	2b	2b	3b	1b	2b	Part of the Applications A package.
EJ0526 (S048) UHF Emissions from Cumulus Clouds (Rossby)				2		Part of the Applications A package.
EJ0529 Multi Channel Radiometer (Rea, Colwell)	1	2	2	1b	3	Part of the Applications A package.
EJ0307 Passive Microwave (Barath)				1	1	OSSA/SAR experiment. An assem- bly of EJ0525, EJ0527, EJ0528. Part of the Applications A package. Candidate for Applica- tions B package.
EJ0525 (S044) Atmospheric Temp. 12 to 75 Kms. (Lenoir)				1		OSSA/SAR passive microwave experi- ment. Part of the composite experi- ment EJ0307. Part of the Applications A package. Candidate for Applications B package.

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TABLE III - 4
PRESENTLY PROPOSED EXPERIMENTS IN THE EARTH DISCIPLINES (CONT'D)

PROPOSED EXPERIMENTS IN MSF EXPERIMENTS CATALOG	EARTH SCIENCES DISCIPLINE SERVED					REMARKS
	Agriculture/ Forestry	Geology/ Hydrology	Geography	Meteorology	Oceanography	
EJ0528 (S044) Microwave Spectral Measurement Near 1.35 cm. (Staelin)				1	1	OSSA/SAR passive microwave experiment. Part of the composite experiment EJ0307. Part of the Applications A package. Candidate for Applications B package.
EJ0527 (S044) Electrically Scanned Microwave Radiometer (Thaddeus)		3		1	2	OSSA/SAR passive microwave experiment. Part of the composite experiment EJ0307. Part of the Applications A package.
EJ0488 (S042) Multiband Synoptic Photography (Orr)	1	1	1	2	1	The basic OSSA/SAR earth photography experiment. Has 13 co-investigators to use the data, not listed as separate experiments. Part of the Applications A package. Candidate for Applications B.
EJ0425 Earth Orbital Infrared A Multi Discipline Scientific Experiment (Lyon)	1	1	1	2	1	The basic OSSA/SAR IR experiment Component or supporting user experiments are EJ0295, EJ0424, EJ0269, EJ0270, EJ0427, EJ0298, EJ0605, EJ0299, EJ0489 not listed here. In addition there are other component or supporting experiments which will be included in the catalogue. Candidate Applications B experiment.

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TABLE III - 5
PRESENTLY PROPOSED EXPERIMENTS IN THE EARTH SCIENCE DISCIPLINES (CONT'D)

PROPOSED EXPERIMENTS IN MSF EXPERIMENTS CATALOG	EARTH SCIENCES DISCIPLINE SERVED					REMARKS
	Agriculture/ Forestry	Geology/ Hydrology	Geography	Meteorology	Oceanography	
EJ0303 Imaging Radar and Two Scattering Coeff. Altimeter Radans (Moore)	1	1	1	2	1	OSSA/SAR experiment. The basic SAR radar experiment. Has 25 co-inves- tigators to use the data. They are not listed as separate experiments. Candidate Applications B experiment.
EJ0296 Radar Cross Section (Brown, Moore)	1b	1b	1b	2b	1b	OSSA/SAR experiment. To obtain in- formation for design and use of EJ0303. Candidate Applications B experiment.
EJ0572 Microwave Radiometry for Sensing World's Oceans (Birnbaum)				1	1	Related to OSSA/SAR passive microwave experiment. Possible candidate ex- periment for Applications B.
EJ0473 VHF Radar Reflectivity (Barringer)		2				OSSA/SAR experiment. Possible Applications B experiment.
EJ0297 Magnetometer Experiment A.E.S. Manned Earth Orbiter (Zietz)		1			3	OSSA/SAR experiment. Possible Applications B experiment.
EJ0120 Atmosphere Iodine (Barringer)		2			2	OSSA/SAR experiment. S/N problem. Possible Applications B experiment.
EJ0293 Apollo Microwave Radiometry (Green)		3		3	3	

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TABLE III - 6

PRESENTLY PROPOSED EXPERIMENTS IN THE EARTH SCIENCE DISCIPLINES (CONT'D)

PROPOSED EXPERIMENTS IN MSF EXPERIMENTS CATALOG	EARTH SCIENCES DISCIPLINE SERVED					REMARKS
	Agriculture/ Forestry	Geology/ Hydrology	Geography	Meteorology	Oceanography	
EJ0622 Ultraviolet photography of Dust in Earth's Upper Atmosphere (Hemenway)				2a		Of more interest to aeronomy.
EJ0114 (S005) Synoptic Terrain Photography (Lowman)	3	2	2		3	Flown on Gemini. Has indicated potential of photography from spacecraft.
EJ0538 Earth's Shape from Radar Altimeter (Yaplee)		2	2			Instrument performance similarity with EJ0303.
EJ0609 Panaromic Camera Supporting Research (Sibert)						Information inadequate for review.. Directed toward developing engineering topographic mapping techniques.

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